

New Jersey Stormwater Best Management Practice Manual

DRAFT • March 2003

<http://www.state.nj.us/dep/watershedmgt/rules/bmpmanual2003.htm>

C H A P T E R 3

Regional and Municipal Stormwater Management Plans

Regional Stormwater Management Plans

Regional stormwater management planning is a water resource management strategy that identifies and develops solutions to problems that can be managed most effectively on a regional basis. The product of this planning process, the regional stormwater management plan (RSWMP), spans the boundaries of individual properties, neighborhoods, municipalities and even county borders. A plan may address an existing water quantity issues, such as localized flooding; an existing water quality issue, such as excess pollutant loading; or issues of water quantity and quality that may be generated by future development. Regional stormwater planning creates a combination of regulations and actions that are tailored to the specific needs of a drainage area. RSWMP does not reduce environmental protection, however. Rather, it allows regulations more flexibility to match the concerns, conditions and features of regions that are connected by a common drainage area.

Well-designed regional stormwater management plans share common elements. First, they are collaborative. Adoption and implementation of an RSWMP depends on the cooperation of county and municipal governing bodies, regulatory agencies, and environmental organizations. Any plan designed without their active involvement and consent has dim prospects for adoption. Second, they focus on identifying and solving specific problems. Shared regional problems, such as recurring flooding, unswimmable lakes, reduced stream flows, or contaminated public water supplies, can drive the collaboration needed to trigger and sustain the planning and adoption process. Specific problems also lend themselves to specific, measurable and quantifiable implementation steps. For example, an RSWMP can spell out the specific measures required to reduce pollutant loads determined by the TMDL (Total Maximum Daily Load) process. Third, an RSWMP's recommendations are based on sound engineering and science specific to local land use conditions. All measures included in an RSWMP must be supported by a rationale that includes a feasibility analysis for achieving specific objectives as well as a monitoring plan to gauge long-run effectiveness of each measure. Plans must be reviewed every five years at a minimum.

Fourth and finally, RSWMPs include a strong emphasis on maintenance and monitoring to ensure long-term functioning of the structures, measures and programs recommended by the plan.

Regional stormwater management planning represents a fundamental shift in thinking – and execution. Traditionally, stormwater has been planned for and managed on a site-by-site basis, with the combined effect of thousands of individual stormwater management decisions in one watershed creating unintended consequences. For example, a detention or retention basin may make perfect sense to manage stormwater for an individual property. Typically, these basins have been designed to ensure that peak runoff rates from a site did not increase after the property was developed. However, when hundreds of such basins simultaneously retain and then release stormwater in a regional drainage area, they can actually increase flooding and downstream erosion by extending peak runoff rates and increases in non-peak flows. As development increased in a drainage area, this site-by-site planning failed to account for the increased volume of runoff caused by regional increases in development. To address those increased volumes, recent regulations, including the proposed Stormwater Management Rules, require stormwater management plans to reduce peak flows leaving a site. The regulations were based on analyses that demonstrate how to prevent increases in the flows that cause both flooding and erosion. However, this statewide method for addressing flooding and erosion may not be the optimum solution for managing runoff for a specific drainage area. For example, an RSWMP may recommend longer detention times at the top of a watershed to release water more slowly into local streams, and the plan may call for reduced detention times in more urbanized sections of the watershed where storage space is limited.

RSWMPs optimize flexible use of stormwater management measures by providing the authority to create new, customized regulatory requirements and by setting priorities for actions that address the specific stormwater quality, quantity and recharge objectives within the planning area. Although performance standards can be changed from those proposed in the Stormwater Management Regulations, RSWMPs must avoid adverse impacts downstream of the planning area. Regional planning also creates more options for groundwater recharge. Local topography, geology and soil conditions that restrict infiltration may present daunting design challenges for some sites and municipalities, while well-suited recharge sites may lie just up or downstream. In each case, better solutions become available with regional planning.

Sizing an RSWMP

Determining the size of a drainage area is one of the first technical challenges in creating an RSWMP. Regional stormwater management is fundamentally a problem-centered planning process, so the size of an RSWMP drainage area may depend on the nature and location of previously identified local concerns, such as water quality impairment, erosion damage, reduced stream flows, sedimentation, inadequate groundwater recharge or flooding. RSWMPs are created to address existing problems or to anticipate and avoid future ones. Local interest groups may already have specific concerns that can be addressed with a regional plan. TMDLs also may require a regional stormwater management plan to develop TMDL implementation requirements for a specific stream segment.

Additional problems may also be identified during the assessment portion of the regional plan development when buildout analysis is performed. A regional plan developed for the Jackson Brook in Morris County, for example, was driven initially by flooding concerns, but it also proposes improvements to reduce pollutant loads projected under full development conditions. A regional plan proposed for the Mulhockaway Creek seeks to anticipate and address concerns of development in an environmentally sensitive area of the South Branch of the Raritan River. A plan proposed for the Cedar Grove Brook in Franklin Township is targeting water-quality issues in an urbanized area just upstream from water supply intakes.

Available funding is a key variable in determining the size of a regional area for a plan. Budgets for developing RSWMPs typically exceed \$100,000 because they often require extensive collection and complex

analysis of field data. Those costs tend to limit the size of the drainage area to be studied, and the regional plans completed or proposed in New Jersey tend to fall between 5 and 20 square miles. The budget for a 12-square-mile drainage area around the Mulhockaway Creek drainage area, for example, is projected at \$300,000. The budget to develop the plan for the 5-square-mile drainage area around Cedar Grove Creek was \$200,000. The cost of implementing an RSWMP, of course, depends on its findings and recommendations. However, if writing a plan can easily run into six figures, implementing one can easily exceed \$1 million if construction of large stormwater management structures is called for in the plan. These costs, however, are dependent on the goals and objectives of the plan and the specific conditions of the area; therefore, costs can vary significantly between regional stormwater management plans.

In New Jersey, with its history of municipal autonomy known as “home rule,” smaller drainage areas also tend to be more politically feasible. Because regional stormwater planning requires municipalities to align their zoning and development standards with the plan, drainage areas that involve three or four neighboring municipalities that share some common concern may have a realistic chance of aligning development standards to solve their shared problem. Those chances would likely drop dramatically if the regional plan involved tens of municipalities lacking a common, immediate problem.

Beginning the Process

By law and by definition, the development of a regional stormwater management plan is a participatory process. In fact, N.J.A.C. 7:8-3, the regulations authorizing regional plans, which are optional, requires creation of a broadly representative regional planning committee as the first step in the process. That committee then designates a Lead Planning Agency that can marshal the technical and administrative resources required to develop and implement a regional plan.

From a technical standpoint, developing a plan begins by characterizing and assessing the drainage area by gathering and reviewing all relevant water quality and quantity information currently available. That means scouring known sources for all available data. These sources can include: State and Federal Emergency Management Agency (FEMA) floodplain maps; hydraulic analysis and stream cross section data from stream encroachment permits; topographic data from aerial photos with two foot contours, water quality data from New Jersey Pollution Discharge Elimination System (NJPDES) permits or intake waters from local water treatment facilities; and monitoring data from the U.S. Geological Survey, the Environmental Protection Agency’s STORET database, the NJDEP, local health departments, environmental commissions or watershed associations. In New Jersey, local Soil Conservation Districts also offer a valuable source of field observations on streambanks, erosion and scouring that can only be collected from walking along stream corridors. Additional information regarding local conditions may be available from the Division of Watershed Management and local environmental organizations. Recent watershed characterization studies, if available, also provide data to focus planning efforts on water quality issues.

If a watershed characterization study is not available, consider performing a relatively quick and inexpensive Geographic Information Systems (GIS) analysis that matches water supply sources with reported water quality degradations and potential pollutant sources.

The full range of steps and requirements for creating, implementing and adopting an RSWMP are included in N.J.A.C. 7:8-3. A summary of those requirements is outlined in this chapter, including:

- A written statement from each public entity on the committee confirming the authority of each to develop and implement a stormwater management plan;
- A discussion of both the majority and minority positions, if portions of the plan do not represent a consensus of the committee;
- Characterization and evaluation of the planning committee’s drainage area;

- Specific objectives for water quality, groundwater recharge and water quantity for the planning committee's drainage area;
- Specific performance standards for water quality, groundwater recharge and water quantity for the committee's planning area; and
- Stormwater management measures selected by the planning committee and an explanation of why they were chosen.

Steps to Create, Implement and Adopt an RSWMP

Planning the RSWMP Process

Because an RSWMP is both a technical planning procedure and a regulatory process, it requires active participation from organizations that would likely be affected by the plan. In fact, the first step in the RSWMP process is to create a regional stormwater management planning committee and Lead Planning Agency for the expressed purpose of developing a regional plan. The committee is charged with soliciting information from the following interested groups and organizations:

- Government agencies at all levels, including Soil Conservation Districts;
- Local and regional environmental groups and organizations, including lake associations, watershed associations and environmental commissions;
- Water supply and wastewater treatment utilities, authorities and agencies, and watershed management planning agencies; and
- Residents in the drainage area.

The planning committee must designate a Lead Planning Agency to serve as the primary contact for the committee. The Lead Agency must submit a request for the recognition of the Regional Stormwater Plan Committee to the NJDEP. This request must include a draft work plan, schedule of activities, and the information used to invite organizations to participate in the planning committee. The NJDEP has 45 days to either approve or deny the request or ask for more information.

Data Gathering and Priority Setting

Data gathering and priority setting can be the most expensive step in the process because it often requires time-intensive collection of field data on variables such as stream elevations, erosion hot spots, and water quality. To minimize the cost of gathering this data, the NJDEP encourages planners to make maximum use of existing information, including information on the department's GIS web site (www.state.nj.us/dep/gis) or information developed through the watershed management process. This task is ideally suited for analysis and display on Geographic Information Systems, and all maps developed must meet New Jersey's digital data standards in N.J.A.C. 7:1D. The following items should be included in your assessment unless it is not pertinent to your specific analysis.

Maps

The maps must first clearly delineate the drainage area boundaries, showing both existing and projected land uses assuming full development under current zoning. The following layers of information should be included: soils, topography, flood hazard areas, well protection and groundwater recharge areas. All water bodies designated as a water quality-limited surface water as well as environmentally sensitive areas or special classifications should be identified, including river areas designated under the *New Jersey Wild and Scenic Rivers Act* or the *Federal Wild and Scenic Rivers Act*. These maps must also identify stormwater

management structures and surface water intakes and public water supply reservoirs. Finally, features that are outside the regional planning areas but discharge or flow into the drainage area should be recorded.

Key stormwater management features

The assessment must include an inventory of all key stormwater management features, including slopes, swales, outfall structures, culverts, and impoundment areas pertinent to stormwater management and required for analyzing the drainage area. Often this data can be gathered only by physically walking stream corridors to record features, such as stream widths, streambank conditions, pollutant sources, eroded areas, and other relevant data. Because this data collection requires trained eyes in the field, this task often accounts for a substantial portion of the cost of developing an RSWMP.

Modeling and analysis

A water quality, groundwater recharge and water quantity hydrologic and hydraulic model or analysis of the drainage area may need to be performed if new performance standards are being proposed. This analysis is critical to identifying the current or potential concerns that drive the entire plan. The analysis must include existing and projected land uses assuming full development under current zoning.

Relevant current regulations

The assessment must identify and evaluate existing municipal, county, state, federal and other regulations related to stormwater management, groundwater recharge, water quality and water quantity, including programs to develop total maximum daily load (TMDLs).

Once the characterization and assessment of the drainage area is complete, the RSWMP must identify current stormwater-related water quality concerns and forecast future ones, assuming full development under current zoning. The inventory should include current and potential stormwater pollutant sources in the regional planning area, such as urban and suburban development, roads, storm sewers, agricultural or mining operations, and waterfront development. Reports and data used to comply with the *Federal Clean Water Act*, Section 303(d) and 305(b) for this step can be valuable, and inexpensive, sources of water quality information.

Once identified, these water-quality concerns must be ranked based on criteria determined by the planning committee. They can include: threat to public health, safety and welfare; damage to water supplies; risk of damage to the biological integrity of water bodies; mosquito control; and groundwater depletion or impacts to the ecosystem, among others.

If a TMDL has already been established for any part of a water body in the planning area, these water-quality objectives must incorporate the loading reductions established in the TMDL for stormwater runoff. If any part of a water body is on the NJDEP's list for compliance with the *Federal Clean Water Act* Section 303(d) for any designated uses by stormwater runoff, the plan's objectives must specifically address those pollutants of concern.

Regional stormwater management plans must also identify and rank issues of water quantity and groundwater recharge as well as water quality. Thus, the broad goal of the plan is to eliminate, reduce or minimize stormwater-related impacts associated with current and future land use. The minimum standard of protection is the level that would be achieved by conforming to New Jersey's Design and Performance Standards for Stormwater Management Measures.

Designing Regional Stormwater Solutions

An RSWMP must include design and performance standards to meet the New Jersey water quality, water quantity and groundwater recharge standards in N.J.A.C. 7:8-3.5. However, because an RSWMP addresses concerns on a regional basis, the design and performance standards need not be uniform throughout the planning area, provided the standards satisfy N.J.A.C. 7:8-5 when considered as a whole. Any alternative standards must be at least as protective to be included in the plan.

Once the objectives and performance standards have been identified, an RSWMP must then outline the stormwater management measures needed to achieve the objectives. The plan may include guidelines for new or existing land uses or other measures, such as: modifying existing stormwater management structural controls; eliminating illegal or illicit discharges; preventing or minimizing exposure to pollutants to stormwater; or controlling floatables. The plan may also include measures to enhance, protect or preserve land or water areas for purposes of flood control, water quality protection, or conservation of natural resources. And, because many stormwater management concerns can be traced directly to the lifestyle choices of watershed residents, a plan may choose to emphasize public education programs to address root causes of water quantity and quality impacts.

Whatever measures are selected, the plan must include two important additional features. First, the plan must explain the committee's rationale for including the selected measure. The rationale should include a feasibility and cost/benefit analysis, an estimate of reduction in pollutant loads and a projection of performance longevity. Second, the plan must specifically address maintenance requirements for each stormwater management measure, including preventative and corrective maintenance, a long-term maintenance implementation schedule and clear identification of the organization or entity responsible for implementation and maintenance.

Implementation and Evaluation Strategies

The implementation strategy begins by identifying the agency assigned to coordinate implementation of the plan, including long-term monitoring requirements. The plan strategy must identify the agency appointed to implement and monitor each measure in the plan along with a timetable for implementation. The implementation strategy must also include a process to evaluate the entire plan at least once every five years. It should also include a budget that projects both long- and short-term costs for each measure. It also should identify possible current and potential funding sources to implement the RSWMP.

The long-term monitoring program should provide information about land use, water quality, water quantity, groundwater, and riparian and aquatic habitat conditions. Monitoring data may include information from watershed management agencies and monitoring programs operated by other agencies, including volunteer programs.

Once complete, an RSWMP plan will be submitted for review to the NJDEP and, if applicable, to the designated water quality management planning agency as an amendment to areawide water quality management plans. If it is approved, the NJDEP will propose to amend the areawide water quality management plan as outlined in N.J.A.C. 7:15-3.4(g). Any performance standards developed under an RSWMP that has been adopted by the Department in effect supersedes the Stormwater Management Rules. NJDEP will use the plan requirements for the review of stormwater management requirements for activities currently regulated by: Coastal Permit Program; Freshwater Wetland Protection Act; Coastal Zone Management Rules; Flood Hazard Area Control Act Rules; New Jersey Pollution Discharge Elimination System Rules; and Dam Safety Standards. Each municipality in the regional stormwater management planning area must incorporate the applicable provisions of the plan into a new or amended municipal stormwater management plan. In addition, stormwater management review for residential developments based on the Residential Site Improvement Standards will be based on the regional stormwater management plan. The requirements of the plan apply only to stormwater management criteria of other regulatory programs; additional requirements may be imposed as necessary under each program.

Municipal Stormwater Management Plan

A municipal stormwater management plan (MSWMP) documents the strategy of a specific municipality to address stormwater-related impacts. Municipal stormwater management plans provide the structure and process for addressing stormwater management in the municipality. MSWMPs are required by the Phase II Stormwater Permitting rules; the mandatory elements of the plan are described in the Stormwater Management Rules.

The municipal plan must address and achieve the goals of stormwater management, discussed in N.J.A.C. 7:8-2. For new development, the plan must incorporate the performance standards for water quantity, water quality and groundwater recharge in the Stormwater Management Rules at N.J.A.C. 7:8-5. If alternate standards have been established by an adopted regional stormwater management plan (RSWMP), the MSWMP must be consistent with the RSWMP. A copy of the ordinances incorporating the performance standards must be included in the plan.

The MSWMP must be coordinated and consistent with other regulations on stormwater management issues, such as the Soil Conservation Districts and the Residential Site Improvement Standards. The MSWMP may also address existing stormwater issues, such as those identified in an RSWMP. In addition to specific design criteria, maintenance and safety requirements are a critical component. Preventative and corrective maintenance strategies must be included in the plan to ensure long-term effectiveness of stormwater management facilities. Safety standards discussed in Subchapter 6 of the Stormwater Management Regulations must also be included in the MSWMP.

The plan must provide a view of the impacts of existing zoning and environmentally constrained areas on the municipality's landscape. The plan must include maps of existing streams, groundwater recharge and wellhead protection areas. The plan must include build-out conditions based on existing zoning as well as an analysis of how the existing master plan and regulations incorporate nonstructural stormwater management measures. In order for the municipality to grant variances or exemptions from the design and performance standards for groundwater recharge, stormwater runoff quality and stormwater runoff quantity, the municipality must provide a mitigation strategy as a component of the MSWMP. The municipality should use the information provided in the plan to ensure that stormwater management objectives are addressed as a whole in the implementation of the municipal plan and ordinances in its entirety.

Municipal stormwater management plans are subject to review by county planning agencies to determine whether the plan meets the standards required by the Stormwater Management Rules. A copy of the proposed plan must also be sent to the State. The county must approve, conditionally approve, or disapprove the plan in writing within 60 days. Generally, the plan becomes effective upon approval by the county; however, in the case of conditional approvals, the plan becomes effective after the municipality meets the conditions of approval.

Mitigation

The municipal stormwater management plan must incorporate design and performance standards that are as protective as those outlined in the Stormwater Management Rules or alternative standards in an adopted regional stormwater management plan. These design and performance standards focus on three areas: maintaining groundwater recharge from proposed development, minimizing the proposed development's impact on flooding, and minimizing the proposed development's water quality impact on the state waters. Some projects have unique, site-specific conditions that prevent them from strict compliance with the performance standards. In order for the municipality to grant a waiver or exemption from strict compliance with the groundwater recharge, stormwater runoff quality and quantity requirements, the MSWMP must include a mitigation plan. The mitigation process must be documented in a mitigation plan contained within the larger MSWMP.

The mitigation plan must identify the measures required to offset any potential impact created by granting the variance or exemption to the performance standards. There are different strategies for mitigating a development project and its impacts. Applicants can identify, design and implement a compensating measure to mitigate impacts. They can complete a project identified by the municipality as equivalent to the environmental impact created by the exemption or variance or they can provide funding for municipal projects that would address existing stormwater impacts.

The preferred option is to identify a mitigation project within the drainage area that directly compensates for the projected impact of the variance or exception. For example, because of natural site constraints, a proposed development might be unable to fully meet the groundwater recharge criteria, with the projected impact being an annual net loss of 50,000 cubic feet of groundwater recharge volume. In this case, a mitigation plan might require, for example, recovery of the lost recharge volume through capturing existing runoff from an impervious area on a site within the same drainage basin. Applicants can be directed to identify potential properties suitable for the mitigation project and to secure the easements necessary to implement the projects.

Municipalities can plan for mitigation by identifying property owned by the municipality or by securing easements, as conditions of planning and zoning board approvals, that would allow implementation of future mitigation measures. Municipalities should develop a list of projects that need to be implemented throughout the municipality that would compensate for groundwater recharge, stormwater quality and stormwater quantity impacts. Project mitigation is simplified when the municipality identifies and ranks a series of projects an applicant can select, especially on land owned or controlled by the municipality. The selection process should be clearly stated so that the applicant and the municipality have predictability in the mitigation process. In its mitigation plan, a municipality can also assign credits for proposed projects that address groundwater recharge, stormwater runoff quantity, and stormwater runoff quality problems within the drainage area.

If direct mitigation for the projected environmental impact is not feasible, an MSWMP may permit a non-equivalent project mitigation. Using the development example above, a mitigation plan may require a mitigation project that helps alleviate an existing impairment, such as fecal contamination in local streams, rather than compensating for the loss of groundwater recharge. Non-equivalent mitigation projects allow a municipality to target the issues of greatest concern within a drainage area and secure the resources to correct them. In this example, the non-equivalent mitigation option might be pursued if close examination of local water resources indicates that fecal impairment is a more critical parameter in the receiving stream than small losses in groundwater recharge and baseflow. Clearly, the non-equivalent mitigation option must be cautiously approached; in this example, the long-term impacts of cumulative losses in groundwater recharge on the aquifer and baseflow must be carefully considered before granting a variance or exception.

The third, and least preferred, mitigation option is to require funding for specific projects within the municipality that would retrofit existing groundwater recharge, stormwater quality or stormwater quantity issues. In urban redevelopment areas, funding projects that address stormwater impacts on a regional basis, such as the development or implementation of regional stormwater management plans, may be more effective than a project that provides direct compensation for the performance standard. In implementing this option, planners should ensure that the funding results in projects that provide adequate protection to compensate for the impact created by failing to strictly comply with the performance standards in the Stormwater Management Rules.

All mitigation plans and reviews should consider the location of mitigation projects in relation to the property where the projected damage will occur. For example, if a project is unable to achieve the stormwater quantity performance standards upstream of an inadequate culvert, a mitigation project downstream of that culvert would not offer similar protection. If the groundwater recharge is the major

contributor to a wetlands area, the new project should continue to provide recharge to the wetlands area. A municipality can develop a mitigation plan that includes any or all of the options discussed above. Mitigation plans can be as simple or as complex as the municipality chooses, provided that they afford sufficient protection of the water quality resources. However, mitigation should not be an option until it is clearly demonstrated that on-site compliance is not practical.

Mitigation requirements should include a hierarchy of options that clearly offset the effect on groundwater recharge, stormwater quantity control, and/or stormwater quality control that was created by granting the variance or exemption. Mitigation must occur within the same drainage basin as that of the proposed development so that it provides similar benefits and protection that would have been achieved if the stormwater and recharge performance standards had been completely satisfied. Because these problems span political boundaries, mitigation projects could be located in adjacent municipalities within the drainage area with the cooperation of the municipalities, especially if a regional stormwater management plan has been developed for the drainage basin. As with any stormwater structure or measure, the mitigation planning and approval process must ensure that long-term maintenance is achieved by clearly assigning responsibility for maintenance and by securing the funding and resources required to perform it.

Mitigation plans can differ greatly from municipality to municipality. As part of the mitigation plan development, consideration should be given to the water resource needs and the ability to implement the plan given the resources of a specific municipality. Outlined below is an example of a mitigation plan.

If a proposed development requests a variance or exemption from strict compliance with the groundwater recharge, stormwater quantity and stormwater quality requirements outlined in the Municipal Stormwater Management Plan and ordinances, the applicant must provide mitigation in accordance with the following:

1. A mitigation project must be implemented in the same drainage area as the proposed development. The project must provide additional groundwater recharge benefits, or protection from stormwater runoff quality and quantity from previously developed property that does not currently meet the design and performance standards outlined in the Municipal Stormwater Management Plan.
 - The applicant can select a project listed on the Municipal Stormwater Management Plan to compensate for the deficit from the performance standards resulting from the proposed project.
 - The developer can obtain the authority to create a project to compensate for the deficit from the performance standards resulting from the proposed project.
 - The developer must ensure the long-term maintenance of the project including the maintenance requirements under Chapters 8 and 9.
2. If a suitable mitigation site cannot be located in the same drainage area as the proposed development, as discussed under Option 1, the municipality may allow the developer to provide funding to the municipality for an environmental enhancement project that has been identified in this Municipal Stormwater Management Plan. [This option would be available only if the MSWMP includes a list of environmental enhancement projects that provide groundwater recharge, control flooding, or control nonpoint source pollution.] The funding must be equal to or greater than the cost to implement the mitigation outlined above, including the costs associated with purchasing the property or easement for mitigation and the costs associated with the long-term maintenance requirements of the mitigation measure.

Build-Out

A build-out analysis allows a municipality to project future development based on its existing zoning and land-use regulations. It develops a picture, projected visually on a map, of what will happen if land is developed to the maximum extent allowed by the law. A build-out analysis is not only useful for communities with undeveloped land. Areas with significant redevelopment potential should be considered in developing a build-out analysis. Many urban and older suburban municipalities contain properties that are not developed to the full extent allowed under current zoning. For example, properties zoned for industrial use currently may contain residential developments. Or, a developer might assemble several small residential and retail properties for demolition and then redevelopment as an office complex. A build-out analysis can identify those properties and project impacts of their potential redevelopment.

Each municipal stormwater management plan is required to include a build-out analysis, with information about the municipality based on the HUC-14 boundaries. A hydrologic unit code 14 (HUC-14) is a specific drainage area defined by the U.S. Geological Survey. For every individual HUC-14 area in the municipality, the full development impervious cover and the anticipated pollutant loading based on full development must be determined.

There are two phases in conducting a build-out analysis. The first visually depicts changes on a map. This phase is best performed using a geographic information system (GIS), a computerized system for developing, analyzing and displaying locational data. GIS allows planners to combine different data sources, such as zoning maps, tax maps, HUC-14, and topographic maps, into “layers” that can be displayed on one map.

- Begin by constructing a base map of your community that includes the municipal boundary, existing roads, surface water bodies, HUC-14 boundaries, impervious cover, groundwater recharge areas, and wellhead protection area layers. Existing GIS information sources may be helpful in the development of this plan, such as the NJDEP-GIS website at <http://www.state.nj.us/dep/gis>. Counties, watershed associations and universities may also have information useful for the development of the base map.
- Identify and delineate land that cannot be developed because of legal restrictions, physical constraints or environmental sensitivity. Examples include lands in permanently preserved open space, public ownership, deed restrictions, utility easements, steep slopes, wetlands, floodplains, and Category 1 Waters with the associated special water resource protection areas.
- Identify and delineate developable land under current zoning and land use regulations. Identify and delineate areas within the municipality that have already been developed with significant redevelopment potential, that have not been developed to the maximum allowed under the zoning. For these undeveloped and underdeveloped areas, project future development to the maximum limit allowed. That means projecting the largest number of housing units allowed in residential zones and the largest number of buildings and most intensive land uses in commercial and industrial zones.

The second phase quantifies the impact of the changes based on the information provided by the maps. This includes calculations of percentage of impervious surfaces, number of housing units and their density, and remaining farmland and open space acreage. GIS can also assist in this computation by providing values for specific sets of layers, such as the combination of the municipality, HUC-14 and impervious area layers. This set of variables can provide the impervious cover for each HUC-14 required by the Stormwater Management Regulations. Values can also be exported to other programs from GIS for more comprehensive computations, such as the pollutant loading calculations also required by the regulations.

The pollutant load computation is a planning tool to help municipalities evaluate anticipated pollutant loads from future development. Nonpoint source pollutant loads from current conditions should be compared to build-out conditions. If BMPs are required the development of undeveloped or underdeveloped

areas by regulation, the implementation of BMPs and their impacts on loading should also be incorporated in the analysis.

To calculate pollutant loads from various land uses for both current and build-out conditions, the table of values below for total suspended solids, nitrogen and phosphorus can be used for a broad perspective on a municipal level. To utilize the table provided, the different zones on the zoning map should be related to the listed land uses. Other pollutant loading values may also be used, provided that it is demonstrated that the values are a better depiction of the municipality. Pollutant loads are required for each HUC-14 in the municipality. For each land use within the HUC-14, multiply the total acreage by the assigned load factor, which is given in pounds per acre per year. The total pollutant load for the HUC-14 will be the sum of the loads for each land use.

Table 1: Pollutant Loads By Land Cover

Land Cover	TP load (lbs/acre/yr)	TN load (lbs/acre/yr)	TSS load (lbs/acre/yr)
High, Medium Density Residential	1.4	15	140
Low density, Rural Residential	0.6	5	100
Commercial	2.1	22	200
Industrial	1.5	16	200
Urban, Mixed Urban, Other Urban	1.0	10	120
Agriculture	1.3	10	300
Forest, Water, Wetlands	0.1	3	40
Barrenland/Transitional Area	0.5	5	60

The build-out analysis can go further than the requirements in the regulations. In addition to pollutant loads and impervious surfaces, it can be used as a tool to assess issues such as open space plans, project school population, and demand on municipal services. The build-out analysis can greatly benefit a municipality by envisioning its future so that steps can be taken to prevent unwanted impacts or plan for future needs. Finally, the build-out analysis should include a summary, with critical findings, conclusions and recommendations.

Evaluation of Master Plan and Municipal Ordinances

The master plan and ordinances of the municipality must be analyzed as part of the requirements for the municipal stormwater management plan. They must be assessed to determine what aspects of the master plan and ordinances limit the use of the nonstructural stormwater management strategies, as discussed in N.J.A.C. 7:8-5.3. These strategies include minimum disturbance, disconnection and minimization of impervious surfaces, pollution prevention techniques, and minimization of lawns. Elements of the plan and ordinances to be evaluated can include items such as minimum parking spaces, curbing, minimum lawn areas, and landscaping. Recommendations for revisions to the master plan and ordinances should be included in the MSWMP.

References

- U.S. Environmental Protection Agency. *How to Do a Build-out Analysis*. Green Communities Website. http://www.epa.gov/greenkit/build_out.htm. March 2003.
- County of Morris, Department of Planning and Development. *Jackson Brook Watershed Stormwater Management Plan*. Prepared by Killam Associates in association with Najarian Associates. March 2001.
- Horner R.H, Skupien J.J., Lingston E.H. & Shaver H.E. *Fundamentals of Urban Runoff Management: Technical and Institutional Issues*. In cooperation with the U.S. Environmental Protection Agency. Terrene Institute, Washington, 1994. Pages 235-248.
- Personal communication with Daniel Van Abs. October 25, 2002
- Personal communication with Tavit O. Najarian. November 11, 2002.
- Personal communication with Christopher Obropta. November 12, 2002, February 21 – March 5, 2003.

References for Table 1: Pollutant Loads By Land Cover

Database of Total Phosphorus, Total Nitrogen, and Total Suspended Solids Export Coefficients

A database of literature values was assembled that includes approximately four-thousand values accompanied by site-specific characteristics such as location, soil type, mean annual rainfall, and site percent-impervious. In conjunction with the database, the contractor reported on recommendations for selecting values for use in New Jersey. Analysis of mean annual rainfall data revealed noticeable trends, and, of the categories analyzed, was shown to have the most influence on the reported export coefficients. Incorporating this and other contractor recommendations, the Department took steps to identify appropriate export values by first filtering the database to include only those studies whose reported mean annual rainfall was between 40 and 51 inches per year. From the remaining studies, total phosphorus, total nitrogen, and total suspended solids values were selected based on best professional judgement for eight land uses categories.

The sources incorporated in the database include a variety of governmental and non-governmental documents. All values used to develop the database and the total phosphorus values in this document are included in the below reference list.

Export Coefficient Database Reference List

- Allison, F.E., E.M. Roller, and J.E. Adams, 1959. Soil Fertility Studies in Lysimeters Containing Lakeland Sand. Tech. Bull. 1199, U.S. Dept. of Agriculture, Washington, D.C. p. 1-62.
- Apicella, G., 2001. Urban Runoff, Wetlands and Waterfowl Effects on Water Quality in Alley Creek and Little Neck Bay. TMDL Science Issues Conference, WEF Specialty Conference.
- Athayde, D. N, P. E. Shelly, E. D. Driscoll, D. Gaboury and G.B. Boyd, 1983. Results of the Nationwide Urban Runoff Program: Final Report. USEPA Water Planning Division. Washington, DC.
- Avco Economic Systems Corporation, 1970. Storm Water Pollution from Urban Land Activity. Rep.11034 FKL 07/70, Federal Water Qual. Adm., U.S. Dept. of Interior, Washington, D.C. p. 325.

- Bannerman, R., K. Baun, M. Bohm, P. E. Hughes, and D. A. Graczyk, 1984. Evaluation of Urban Nonpoint Source Pollution Management in Milwaukee, County, Wisconsin, Report No. PB84-114164, U.S. Environmental Protection Agency, Region V, Chicago, IL.
- Bengtson, R.L. and C.E. Carter, 1989. Simulating Soil Erosion in the Lower Mississippi Valley with the CREAMS Model. From: Application of Water Quality Models for Agricultural and Forested Watersheds, edited by D.B. Beasley and D.L Thomas. Southern Cooperative Series Bulletin No. 338.
- Broadbent, F.E., and H.D. Chapman, 1950. A Lysimeter Investigation of Gains, Losses and Balance of Salts and Plant Nutrients in an Irrigated Soil. Soil Sci. Soc. Amer. Proc. 14:261-269.
- Carter, Gail P., 1998. Estimation of Nonpoint Source Phosphorus and Nitrogen Loads in Five Watersheds in New Jersey's Atlantic Coastal Drainage Basin. Surveying and Land Information Systems, Vol. 58, no 3. pp167-177.
- CH2M Hill, 2000. Technical Memorandum 1, Urban Stormwater Pollution Assessment, prepared for North Carolina Department of Environment and Natural Resources, Division of Water Quality.
- Claytor, R.A. and T.R. Schueler, 1996. "Design of Stormwater Filtering Systems," The Center for Watershed Protection, Prepared for Chesapeake Research Consortium, Inc.
- Corsi, S.R., D.J. Graczyk, D.W. Owens, R.T. Bannerman, 1997. Unit-Area Loads of Suspended Sediment, Suspended Solids, and Total Phosphorus From Small Watersheds of Wisconsin. USGS FS-195-97.
- Delaware Valley Regional Planning Commission, 1977. Average Pollutant Concentrations Associated with Urban Agriculture and Forest Land Use. Working Paper 5.01-1, Extent of NPS Problems.
- Eck, P., 1957. Fertility Erosion Selectiveness on Three Wisconsin Soils. Ph. D. Thesis, Univ. of Wisconsin, Madison, WI.
- F.X. Brown, Inc., 1993. Diagnostic-Feasibility Study of Strawbridge Lake. FXB Project Number NJ1246-01.
- Frink, C.R., 1991. Estimating Nutrient Exports to Estuaries. Journal of Environmental Quality. 20:717-724.
- Horner, R., B. W. Mar, L. E. Reinelt, J. S. Richey, and J. M. Lee, 1986. Design of monitoring programs for determination of ecological change resulting from nonpoint source water pollution in Washington State. University of Washington, Department of Civil Engineering, Seattle, Washington.
- Horner, R.R., 1992. Water Quality Criteria/Pollutant Loading Estimation/Treatment Effectiveness Estimation. In R.W. Beck and Associates. Covington Master Drainage Plan. King County Surface Water Management Division., Seattle, WA.
- Horner, Richard R., Joseph J. Skupien, Eric H. Livingston, and H. Earl Shaver, 1994. Fundamentals of Urban Runoff Management: Technical and Institutional Issues. Prepared by the Terrene Institute, Washington, DC, in cooperation with the U.S. Environmental Protection Agency. EPA/840/B-92/002.
- Johnston, W.R., F. Ittihadieh, R.M. Daum, and A.F. Pillsbury, 1965. Nitrogen and Phosphorus in Tile Drainage Effluent. Soil Sci. Soc. Amer. Proc. 29:287-289.
- Knoblauch, H.C., L. Kolodny, and G.D. Brill, 1942. Erosion Losses of Major Plant Nutrients and Organic Matter from Collington Sandy Loam. Soil Sci. 53:369-378.
- Loehr, R.C., 1974. Characteristics and comparative magnitude of non-point sources. Journal of WPCF 46(11):1849-1872.
- Lopes, T.J., S.G. Dionne, 1998. A Review of Semivolatile and Volatile Organic Compounds in Highway Runoff and Urban Stormwater. U.S. Geological Survey, U.S. Department of Interior.
- Marsalek, J., 1978. Pollution Due to Urban Runoff: Unit Loads and Abatement Measure, Pollution from Land Use Activities Reference Group. International Joint Commission, Windsor, Ontario.

- McFarland, Anne M.S and L. M. Hauck, 2001. Determining Nutrient Export Coefficients and Source Loading Uncertainty Using In-stream Monitoring Data. *Journal of the American Water Resources Association*, pp. 223, 37. No. 1, February.
- Menzel, R. G., E. D. Rhoades, A. E. Olness, and S. J. Smith, 1978. Variability of Annual Nutrient and Sediment Discharges in Runoff from Oklahoma Cropland and Rangeland. *Journal of Environmental Quality*, 7:401-406.
- Mills, W.B., D.B. Porcella, M.J. Unga, S.A. Gherini, K.V. Summers, L. Mok, G.L. Rupp, G.L. Bowie, 1985. Water Quality Assessment – A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water – Part I and II. EPA-600/6-85-002A&B.
- Minshall, N.E., M.S. Nichols, and S.A. Witzel, 1969. Plant Nutrients in Base Flow of Streams in Southwestern Wisconsin. *Water Resources*. 5(3):706-713.
- Mundy, C., M. Bergman, 1998. Technical Memorandum No. 29, The Pollution Load Screening Model: A tool for the 1995 District Water Management Plan and the 1996 Local Government Water Resource Atlases, Department of Water Resources, St. Johns River Water Management District.
- NCDWQ, 1998. Neuse River Basinwide Water Quality Plan, Chapter 5, Section A.
- Nelson, M.E., 1989. Predicting Nitrogen Concentrations in Ground Water An Analytical Model. IEP, Inc.
- Northeast Florida Water Management District, 1994. St. Marks and Wakulla Rivers Resource Assessment and Greenway Protection Plan. Appendix 4.
- Northern Virginia Planning District Commission, 1979. Guidebook for Screening Urban Nonpoint Pollution Management Strategies. Prepared for the Metropolitan Washington Council of Governments.
- Novotny, V., H. Olem, 1994. *Water Quality: Prevention, Identification, and Management of Diffuse Pollution*. Van Nostrand Reinhold, NY
- Omernik, J. M., 1976. The influence of land use on stream nutrient levels, US EPA January. EPA-60/3-76-014
- Omni Environmental Corporation, 1991. Literature Search on Stormwater Pollutant Loading Rates. Literature cited from DVRPC 1977; Wanielista et al. 1977; Whipple and Hunter 1977; NVPDC 1980; USEPA 1983; Mills et al. 1985; Nelson 1989; Walker et al. 1989.
- Omni Environmental Corporation, 1999. Whippany River Watershed Program Stormwater Model Calibration and Verification Report.
- Overcash, M. R., F. J. Humenik, and J. R. Miner, 1983. *Livestock Waste Management*, Vol. II, CRC Press, Inc., Boca Raton, Florida.
- Pacific Northwest Environmental Research Laboratory, 1974. Relationships Between Drainage Area Characteristics and Non-Point Source Nutrients in Streams. Prepared for the National Environmental Research Center, August 1974.
- Panuska, J.C. and R.A. Lillie, 1995. Phosphorus Loadings from Wisconsin Watersheds: Recommended Phosphorus Export Coefficients for Agricultural and Forested Watersheds. Research Management Findings, Bureau of Research, Wisconsin Department of Natural Resources, Number 38.
- Pitt, R.E., 1991. Nonpoint Source Water Pollution Management. Dep. Civil Eng., Univ. Alabama, Birmingham, AL.
- Polls, Irwin and Richard Lanyon, 1980. Pollutant Concentrations from Homogeneous Land Uses. *Journal of the Environmental Engineering Division*.
- Prey, J., D. Hart, A. Holy, J. Steuer, J. Thomas, 1996. A Stormwater Demonstration Project in Support of the Lake Superior Binational Program: Summary. Wisconsin Dept. of Natural Resources. (<http://www.dnr.state.wi.us/org/water/wm/nps/tpubs/summary/lakesup.htm>)

- Rast, W. and G.F. Lee, 1978. Summary Analysis of the North American (U.S. Portion) OECD Eutrophication Project: Nutrient Loading -- Lake Response Relationships and Trophic State Indices., EPA-600/3-78-008.
- Reckhow, K.H., M.N. Beaulac and J.T. Simpson, 1980. Modeling of Phosphorus Loading and Lake Response Under Uncertainty: A Manual and Compilation of Export Coefficients. Report No. EPA 440/5-80-011. U.S. EPA, Washington, D.C.
- Ryding, S. and W. Rast, 1989. The Control of Eutrophication of Lakes and Reservoirs. Man and the Biosphere Series, United Nations Educational Scientific and Cultural Organization, Paris, France.
- Schueler, T.R., 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Prepared for the Metropolitan Washington Council of Governments.
- Sonzogni, W.C. and G.F. Lee, 1974. Nutrient Sources for Lake Mendota - 1972. Trans. Wisc. Acad. Sci. Arts Lett. 62:133-164.
- Uchrin, C.G. and T.J. Maldanato, 1991. Evaluation of Hydrocarbons in Urban Runoff and in Detention Basins. Water Writes. Water Research Institute, Division of Coastal and Environmental Studies, Rutgers University.
- United States Geological Survey, U.S. Department of the Interior, 1998. Comparison of NPDES Program Findings for Selected Cities in the United States, USGS Fact Sheet, January
- USEPA, 1987. Guide to Nonpoint Source Pollution Control. U.S. EPA, Criteria and Standards Division, Washington D.C.
- USEPA, 1993. Urban Runoff Pollution Prevention and Control Planning (handbook). EPA/625/R-93/004.
- USEPA, 2000. Watershed Analysis and Management (WAM) Guide for Tribes.
(<http://www.epa.gov/owow/watershed/wacademy/wam/>)
- Uttormark, P.D., J.D. Chapin, and K.M. Green, 1974. Estimating nutrient loadings of lakes from non-point sources. U.S. Environmental Protection Agency, Washington, D.C. 112 p. (WRIL 160609). EPA-660/3-74-020.
- Walker, J.F., 1989. Spreadsheet Watershed Modeling for Nonpoint Source Pollution Management in a Wisconsin Basin, Water Resources Bulletin, Vol. 25, no. 1, pp. 139-147.
- Wanielista, M.P., Y.A. Yousef, and W.M. McLellon, 1977. Nonpoint Source Effects on Water Quality, Journal Water Pollution Control Federation, Part 3, pp. 441-451.
- Washington State Department of Ecology, 2000. Stormwater Management Manual for Western Washington: Volume I Minimum Technical Requirements. Publication No. 99-11.
- Weidner, R.B., A.G. Christianson, S.R. Weibel, and G.G. Robeck, 1969. Rural Runoff as a Factor in Stream Pollution. J. Water Pollution. Con. Fed. 36(7):914-924.
- Whipple, W. and J.V. Hunter, 1977. Nonpoint Sources and Planning for Water Pollution Control. Journal Water Pollution Control Federation. pp. 15-23.
- Whipple, W., et al., 1978. Effect of Storm Frequency on Pollution from Urban Runoff, J. Water Pollution Control Federation. 50:974-980.
- Winter, J.G. and H.C. Duthie, 2000. Export Coefficient Modeling to assess phosphorus loading in an urban watershed. Journal of American Water Resources Association. Vol. 36 No. 5.
- Zanoni, A.E., 1970. Eutrophic Evaluation of a Small Multi-Land Use Watershed. Tech. Completion Rep. OWRR A-014-Wis., Water Resources Center, Univ. of Wisconsin, Madison, WI.